

Sandra K. Hnat

EDUCATION

Cleveland State University, Cleveland, Ohio USA
Washkewicz College of Engineering

Doctor of Engineering in Mechanical Engineering, May 2018

- Dissertation: Neuromuscular Reflex Control for Prostheses and Exoskeletons
- Advisor: Antonie J. van den Bogert
- Area of Study: human motion control, prostheses control, biomechanics
- Coursework: Robot Dynamics and Control, Intelligent Control Systems, Human Motion and Control, Neuroscience, Gross Anatomy and Lab, Advanced Dynamics, Advanced Optimization, Nonlinear Systems, System Identification

Bachelor of Mechanical Engineering, May 2013

- GPA: 3.79
- *Magna Cum Laude*
- Tau Beta Pi member
- Senior Capstone Project: Parker Hannifin Chainless Challenge Hydraulic Bicycle Competition, Irvine, California USA, 2013
- Coursework: Modeling and Simulation of Mechatronic Systems, Mechanical Systems Lab, Advanced Machine Analysis, Kinematics and Machine Dynamics, Computer Aided Engineering Design, Vibrations, Programming with MATLAB, Finite Element Analysis

Cuyahoga Community College, Parma, Ohio USA

Associate of Science, June 2010

- GPA: 3.93
- *Summa Cum Laude*

TEACHING INTERESTS

- | | |
|---------------------------|--------------------------|
| • Programming with MATLAB | • Linear Algebra |
| • Kinematics | • Engineering Economy |
| • Statics | • Dynamics |
| • Strength of Materials | • Machine Design |
| • SolidWorks | • Thermodynamics |
| • Biomechanics | • Robotics |
| • Linear Controls | • Differential Equations |

RESEARCH

Case Western Reserve University, Department of Biomedical Engineering

EXPERIENCE

Postdoctoral Scholar

Louis Stokes Veterans Affairs Hospital, Advanced Platform Technology Center

Research Associate, Without Compensation Employee

July 2018-present

Principal Investigators: Ronald J. Triolo, Musa L. Audu, Roger D. Quinn, and Rudolph Kobetic

- Investigated estimating whole body center of mass to be used as feedback for a balance controller in a hybrid exoskeleton
- Investigated using Kalman Filters to estimate whole body center of mass and validated the model using walking data recorded through motion capture
- Developed a center of mass estimation algorithm using accelerometers and other sensors to estimate whole body center of mass during standing under the effect of external and internal perturbations
- Participated and assisted other researchers in the Motion Study Laboratory in over 5 different studies using subjects with spinal cord injuries and functional neural stimulation
- Designed and conducted external and internal perturbation experiments using motion capture and linear actuators, using multiple subjects
- Generated musculoskeletal standing models in OpenSim to represent perturbation experiment protocols
- Pioneered the reorganization of the shared research drive, organized a project team, and designed a MATLAB script to automatically generate links and folders based on subjects and funded IRB projects
- Organized and led hybrid team project meetings and recorded meeting minutes

Cleveland State University, Cleveland, Ohio USA

Parker Hannifin Laboratory for Human Motion and Control

Graduate Research Assistant, May 2013 – May 2018

- Invented method for compensating inertial artifacts in ground reaction force data due to moving platforms and treadmill rollers
- Created software for simulating muscle dynamics and reflexes in real-time
- Controlled an exoskeleton using virtual muscle and reflex control
- Designed and conducted experiments in modern human gait lab using multiple subjects
- Developed post-processing software for detailed analysis of recorded data
- Acted as liaison with vendors for troubleshooting laboratory hardware and software
- Led tours and equipment demonstrations for high school students, vendors, and business partners
- Trained undergraduate and graduate students in using laboratory equipment
- Manager and administrator of lab website
- Drafted instructions and troubleshooting documents for lab procedures

TEACHING EXPERIENCE

Differential Equations for Engineers

Cleveland State University

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Fall 2019 – Spring 2021

- Class of over 40 students
- Both on-site and remote learning experience

WORK EXPERIENCE

COTSWORKS, Highland Heights, Ohio, USA

Mechanical Engineering Intern, October 2011-February 2012

- Authored more than 20 company procedures in alignment with ISO 9000 standards
- Developed process for tracking company assets and inventory
- Tested and calibrated precision equipment, such as oscilloscopes, test racks, voltmeters, and static-sensitive workstations
- Using SolidWorks software, modeled complex fiber optic component assemblies
- Assembled and quality tested fiber optic transceivers and cables according to military grade specifications

PUBLICATIONS

- [1] **S. K. Hnat** and A. J. van den Bogert. *Virtual Muscles and Reflex Control Generates Human-like Ankle Torque during Gait Perturbations*. Under review IEEE Transactions on Biomedical Engineering.
- [2] **S. K. Hnat**, H. Wang, and R. Nataraj. *Evaluation of a Virtual Muscle Model using a Powered Exoskeleton*. Under review Applied Bionics and Biomechanics.
- [3] A. D. Koelewijn, M. Audu, A. J. del-Ama, A. Colucci, J. M. Font-Llagunes, A. Gogeoascoechea, **S. K. Hnat**, N. Makowski, J. C. Moreno, M. Nandor, R. Quinn, M. Reichenbach, R.-D. Reyes, M. Sartori, S. R. Soekadar, R. Triolo, M. Vermehren, C. Wenger, U. S. Yavuz, D. Fey, P. Beckerle. *Adaption Strategies for Personalized Gait Gait Neuroprosthetics*. Frontiers in Neurorobotics. Accepted for publication.
- [4] **S. K. Hnat**, M. L. Audu, R. J. Triolo, and Roger D. Quinn. *Estimating COM Kinematics during Perturbed Standing using Accelerometers*. Journal of Applied Biomechanics. 37(5): 415-424, 2021.
- [5] **S. K. Hnat**, B. J. H. van Basten, and A. J. van den Bogert. *Compensation for Inertial and Gravity Effects in a Moving Force Platform*. Journal of Biomechanics, 75: 96-101, 2018.
- [6] J. K. Moore, **S. K. Hnat**, and A. J. van den Bogert. *An elaborate data set on human gait and the effect of mechanical perturbations*. PeerJ 3:e918, 2015.
- [7] **S. K. Hnat** and A. J. van den Bogert. *Inertial Compensation for Belt Acceleration in an Instrumented Treadmill*. Journal of Biomechanics, 47(15): 3758 – 3761, 2014.

CONFERENCE ABSTRACTS &

- [1] **S. K. Hnat**, Ryan-David Reyes, Mark Nandor, Nathan Makowski, Musa Audu, Ronald Triolo, Roger Quinn. *Iterative Learning Control and Balance*

PRESENTATIONS

- Control for Walking in a “Muscles-First” Motor-Assisted Hybrid Neuroprosthesis*. 50th Annual Meeting, Neuroscience 2021. Virtual, November 2021.
- [2] **Invited Speaker: S. K. Hnat**, *A Muscles-First Motor-Assisted Neuroprosthesis (MAHNP) to Restore Gait for Users with Spinal Cord Injury*. Breakthroughs in Orthopedic Rehabilitation. Cleveland, OH, USA, October 2021.
- [3] **S. K. Hnat**, Ryan-David Reyes, Mark Nandor, Nathan Makowski, Rudolf Kobetic, Musa Audu, Ronald Triolo, Roger Quinn. *A Muscle-First Motor-Assisted Hybrid Neuroprosthesis to Restore Gait for Users with Paralysis*. International IEEE EMBS Conference on Neural Engineering. Virtual, May 2021.
- [4] R. Quinn, M. Audu, R. Triolo, R.-D. Reyes, M. Nandor, **S. Hnat**. C. Liu, N. Makowski. *Integrated Control of Biological and Mechanical Power for Standing Balance and Gait Stability after Paralysis*. NSF Cyber-Physical Walking Systems Principal Investigators’ Meeting. Virtual, June 2021.
- [5] **S. K. Hnat**, M. L. Audu, Ronald J. Triolo. *Estimating Center of Mass Kinematics during Human Walking using Accelerometers*. Dynamic Walking. Virtual, May 2020.
- [6] **S. K. Hnat**, M. L. Audu, and R. J. Triolo. *Estimating Center of Mass Kinematics during Human Standing using Inertial Measurement Units*. Biomedical Engineering Society, Philadelphia, PA, USA, October 2019.
- [7] R. Quinn, M. Audu, R. Triolo, M. Nandor, **S. Hnat**. C. Liu. *Integrated Control of Biological and Mechanical Power for Standing Balance and Gait Stability after Paralysis*. NSF Cyber-Physical Walking Systems Principal Investigators’ Meeting. Arlington, VA, USA, November 2019.
- [8] **S. K. Hnat** and A. J. van den Bogert. *Are Virtual Muscles and Reflex Control Capable of Describing Variations within the Human Gait Cycle?* American Society of Biomechanics Midwest Meeting, Grand Valley State University, Grand Rapids, Michigan USA, February 2017.
- [9] **S. K. Hnat** and A. J. van den Bogert. *Virtual Muscles and Reflex Controllers are Capable of Describing Human Gait and Responses to Perturbation*. Dynamic Walking, Camp Ohiyesa, Holly, Michigan, USA, June 2016.
- [10] **S. K. Hnat** and A. J. van den Bogert. *A Real-Time Virtual Muscle System for Prosthesis Control*. Dynamic Walking, The Ohio State University, Columbus, Ohio USA, July 2015.

CONFERENCE ABSTRACTS &

- [11] **S. K. Hnat** and A. J. van den Bogert. *Real-Time Virtual Muscle Control for Prostheses and Exoskeletons*. 25th Congress of the International Society of

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**PRESENTATIONS
(continued)**

Biomechanics, The Scottish Exhibition and Conference Center, Glasgow, Scotland, July 2015.

- [12] **S. K. Hnat** and A. J. van den Bogert. *A Real-Time Virtual Muscle Controller for Powered Prostheses*. American Society of Biomechanics Midwest Meeting, The University of Akron, Akron, Ohio USA, February 2015.
- [13] **S. K. Hnat** and A. J. van den Bogert. *Inertial Compensation in Moving Force Plates*. World Congress of Biomechanics, Hynes Convention Center, Boston, Massachusetts, USA, July 2014.
- [14] J. K. Moore, **S. K. Hnat**, and A. J. van den Bogert. *Identification of Human Control during Walking*. Dynamic Walking, ETH Zurich, Zurich, Switzerland, June 2014.
- [15] **S. K. Hnat** and A. J. van den Bogert. *Inertial Compensation in Moving Force Plates*. American Society of Biomechanics Midwest Meeting, The University of Akron, Akron, Ohio USA, February 2014.

**PROFESSIONAL
AFFILIATIONS**

- American Society of Biomechanics, 2015—
- International Society of Biomechanics, 2014—
- American Society of Biomechanics, 2017—

**ACADEMIC
SERVICE**

Journal reviewer for:

- Journal of Biomechanics (2018—)
- IEEE Access (2019—)
- PLOS One (2019—)
- RATE (2019—)
- VA Internal Reviewer (2021—)

WISHED Connect Her Mentorship Program (2019—)

Case Western Reserve University Post Doctoral Association (2019—2020)

WISR (2020—)

Senior Projects SOURCE Intersections Judge and Moderator
Case Western Reserve University (2019 -)

T32 Musculoskeletal Seminar Schedule Organizer (2021-)

TECHNICAL SKILLS

Software Proficiencies: MATLAB, Simulink, SolidWorks, 20-sim, Mathcad, Maple, Cortex Motion Analysis, D-Flow Gait Analysis, Autolev, OpenSim, Microsoft Office, LaTeX, Vicon

Programming Languages: MATLAB, Python, Lua, C++, HTML, CSS

HONORS AND AWARDS

Kefka Research Award, 2017

Cleveland State University

1st Place Mechanical Engineering Research Poster, \$300

Title: *Neuromuscular Reflex Controllers can Describe Human Gait and Responses to Perturbation*

Research Day Poster Competition, 2016

Cleveland State University

2nd Place in Poster Competition, \$200

Title: *A Real-Time Virtual Muscle System for Prosthesis Control*

David A. Winter Young Investigator Award, 2015

International Society of Biomechanics Conference, Glasgow, Scotland
(One of three finalists)

Parker Hannifin Graduate Research Fellowship, 2013

Cleveland State University, Annual Stipend \$25,000

Dissertation: Virtual Muscle and Reflex Control for Prostheses

Lubrizol Scholarship, 2012

Cleveland State University, \$2000